

# Introduction

- **The focus of the class is on basic machine learning (ML) ideas and concepts.** This approach allows students to easily acquire the terminology and continue to study independently after finishing the class - through books, videos and software documentation.
- **The course is project-based.** Each time the selection of the projects is different. It depends on the math knowledge of the students. First several projects are demonstrated to the whole class and utilize minimal mathematical background among students. Students do not have to learn new math but see how their existing math knowledge can be used in ML.
- **Many students already have experience with some ML methods.** Our class is helpful for understanding similarities between familiar methods.
- **This course is very open.** The minimal mathematical background required for this class is: solving systems of linear equations and inequalities.
- **Topics of machine learning are grouped by required mathematical background.**
- **Relationship with other disciplines is highlighted** - statistics, probability, linear algebra, operations research, optimization, financial engineering.
- **Students work in groups.** Members of the group may have different skills, and the reason is to have a variety of skills present in the group: computer programming, mathematics, mathematical modeling, subject matter expert knowledge. This allows to complete realistic projects.
- **Educational software *minpy* is used for many projects,**

# What is Project?

Demonstration projects show how to solve real life problem using machine learning approach.

## **Project consists of 5 steps:**

- ❖ problem formulation
- ❖ creating mathematical model of the problem
- ❖ preparing input data
- ❖ developing a solution/writing computer code
- ❖ running/testing the code
- ❖ analyzing the solution

When working in groups students may divide the responsibilities inside the group and work on subtasks in parallel: preparing data, writing code, preparing report, etc

Depending on math background of a student he or she may be assigned a project where higher level of math is needed.

# Demonstration projects

1. The Diet problem (famous problem from Operation Research)
2. Principal component Analysis of food dataset
3. Matrix games (investors playing against market, Morra game)
4. Stock portfolio optimization
5. Airplane classification
6. Credit rating assignment
7. Customer deposit behavior prediction
8. Telecom churn analysis
9. Movie recommendation system
10. Genetic algorithm for portfolio optimization
12. PSO vs Genetic Algorithm for index tracking
13. Design of learning strategies using educational software *minpy*
14. Monte Carlo method for computing Pi
15. Nelder and Mead optimization strategy for robot parameters tuning
16. Nelder and Mead optimization strategy for alloy design
17. Coordinate descent vs Nelder and Mead using *minpy* modules

## More on *minpy* projects

***Minpy* was developed with this course in mind.**

**Following projects are based on minpy:**

**Implementing Nelder and Mead algorithm using minpy modules**

**Implementing PSO using minpy modules**

**Implementing CMA-ES using minpy modules**

**See this link to learn more about *minpy***

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